LArIAT Group Meeting

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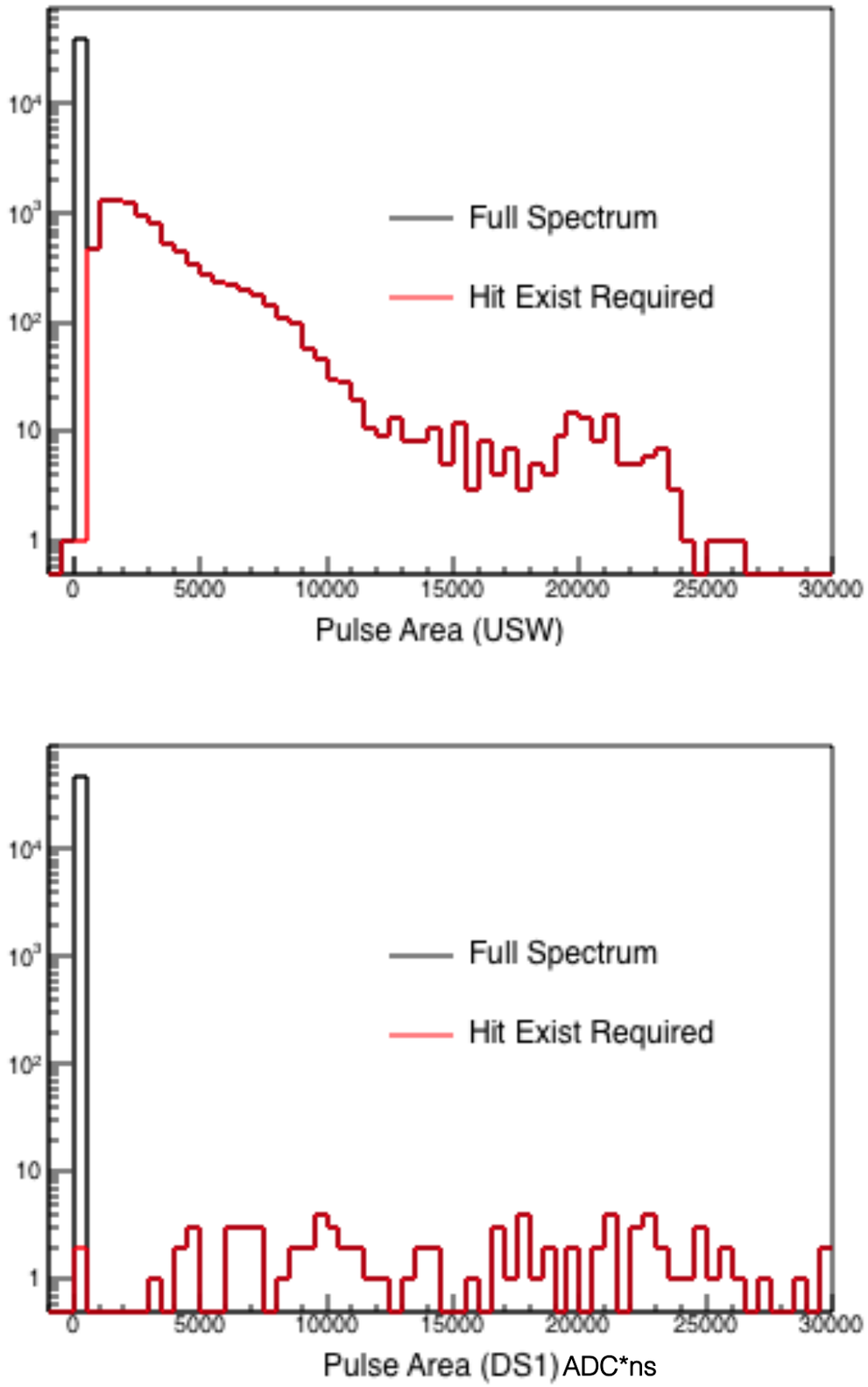
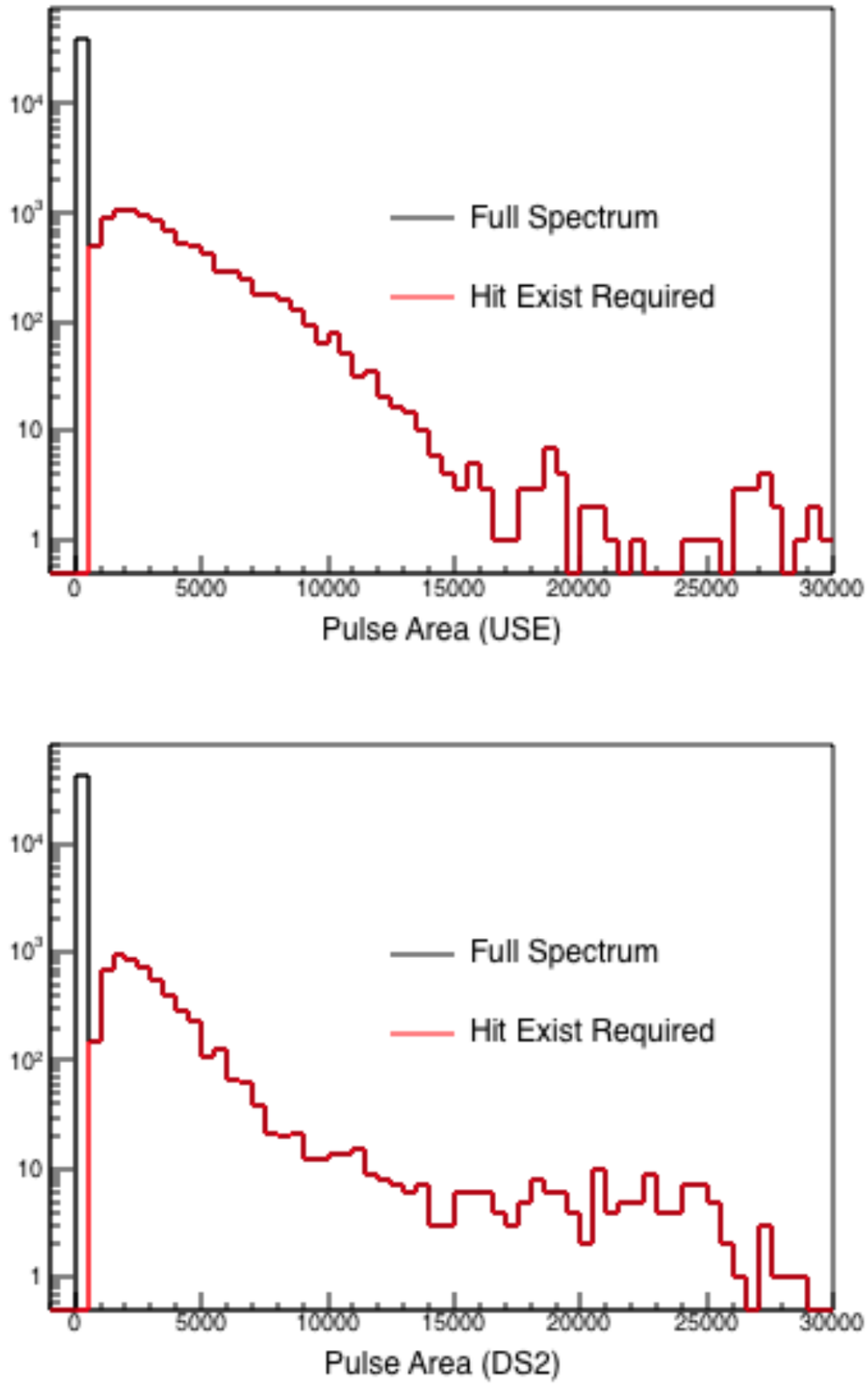
Aerogel

- Instructions used to produce analysis using LArSoft
  https://cdcvs.fnal.gov/redmine/projects/lardbt/wiki/AGCodes
- Our naming convention for the four aerogel PMTs is:
  US E/W are the two PMTs for the KEK counter (Hamamatsu H1161)
  DS 1 is (the 3” square Photonis XP5382 PMT)
  DS 2 is (the 2” circular EMI 9954B PMT.)

Aerogel Pulse Area

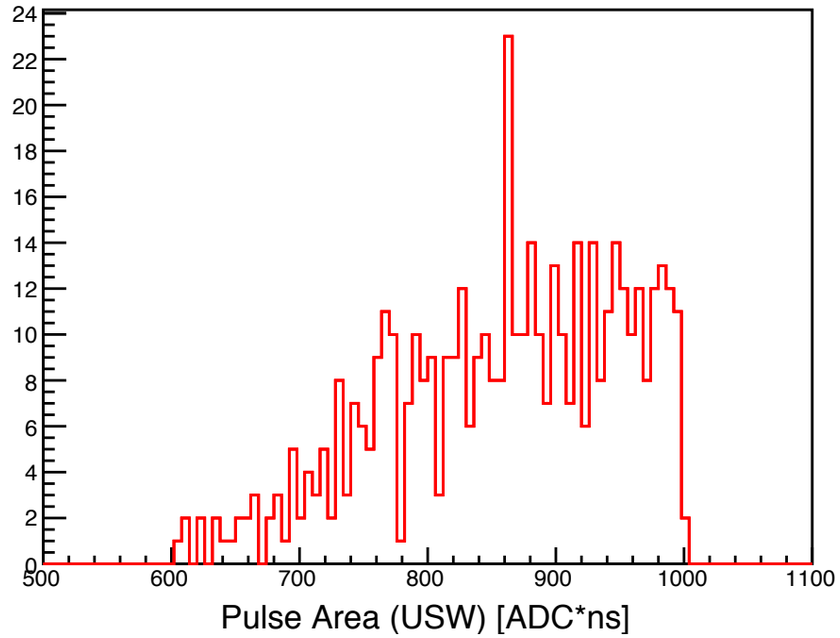
- Pulse Area for each PMT with & without aerogel hit exist cuts applied

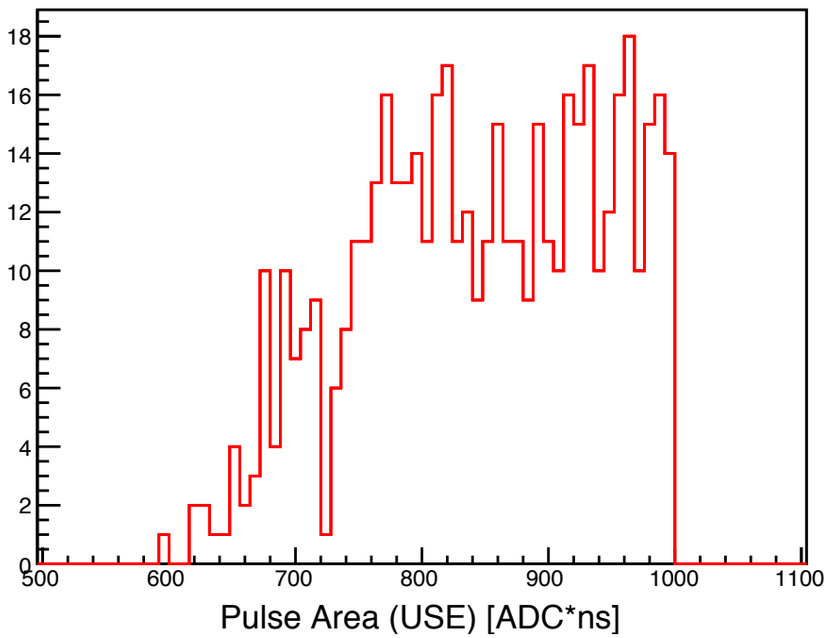


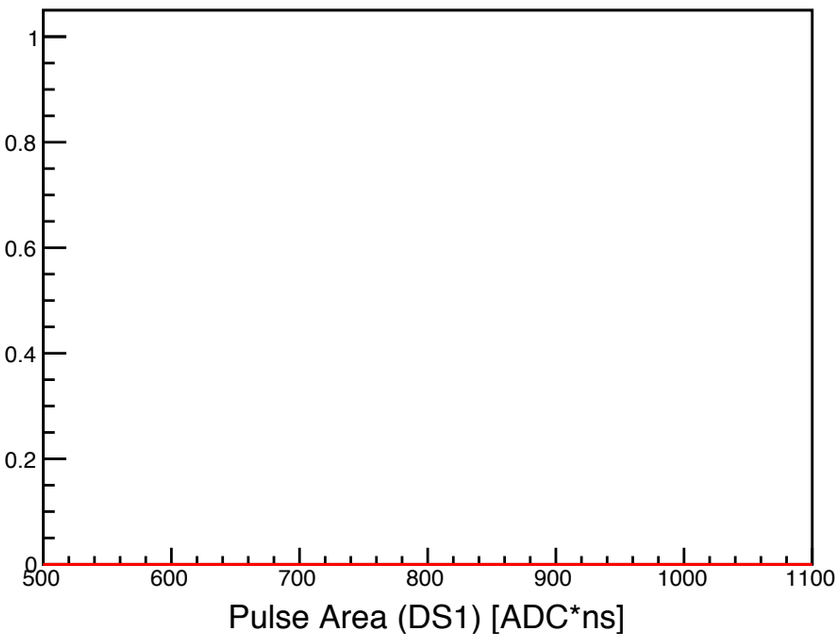


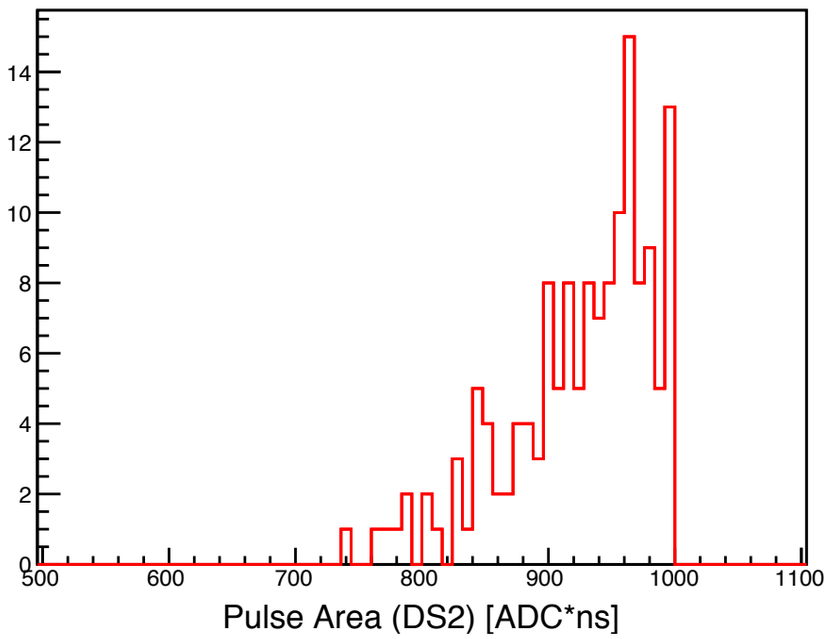
Aerogel Pulse Area

- Pulse Area for each PMT with aerogel hit exist cuts applied below 1000ADCns
- Unable to see a single P.E
- Is this an affect from our pulse area algorithm?



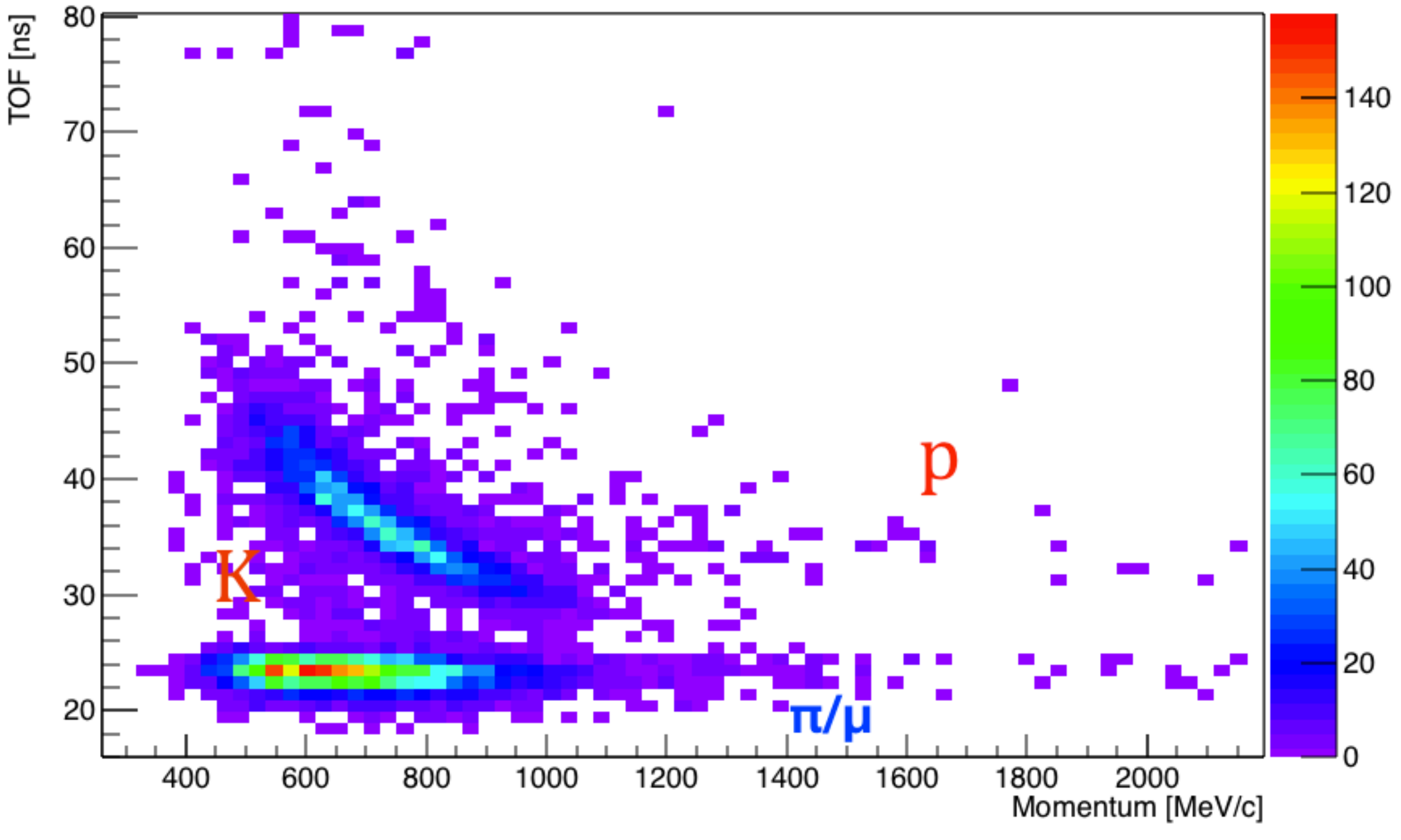






TOF

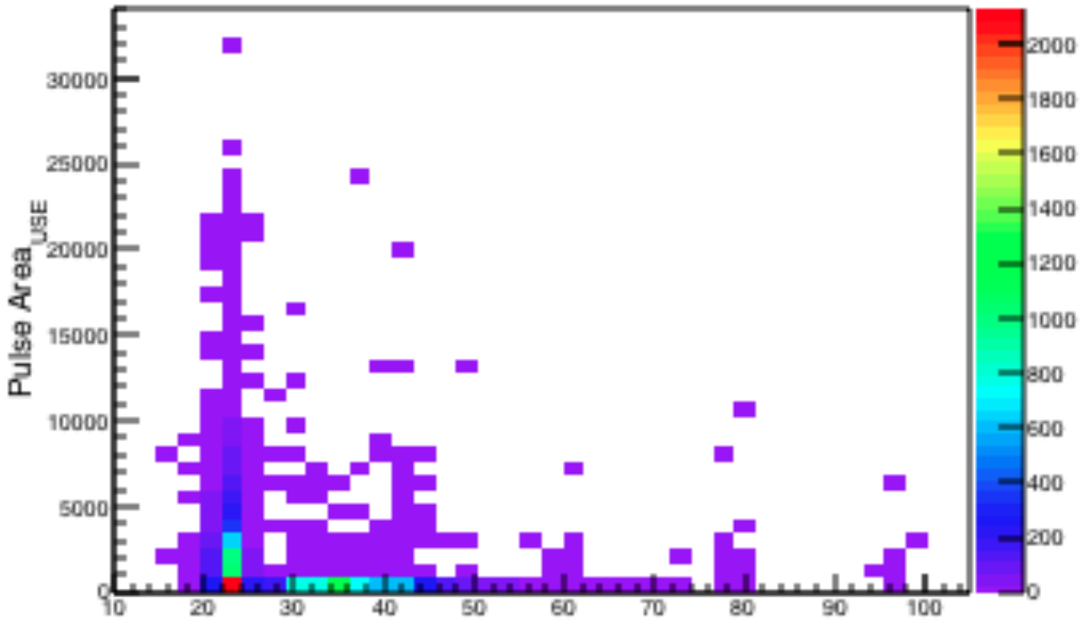
- TOF allows for π/μ & proton separation
- TOF + WC's you can do particle ID (π/μ, p, K) before the particle enters your LArTPC.

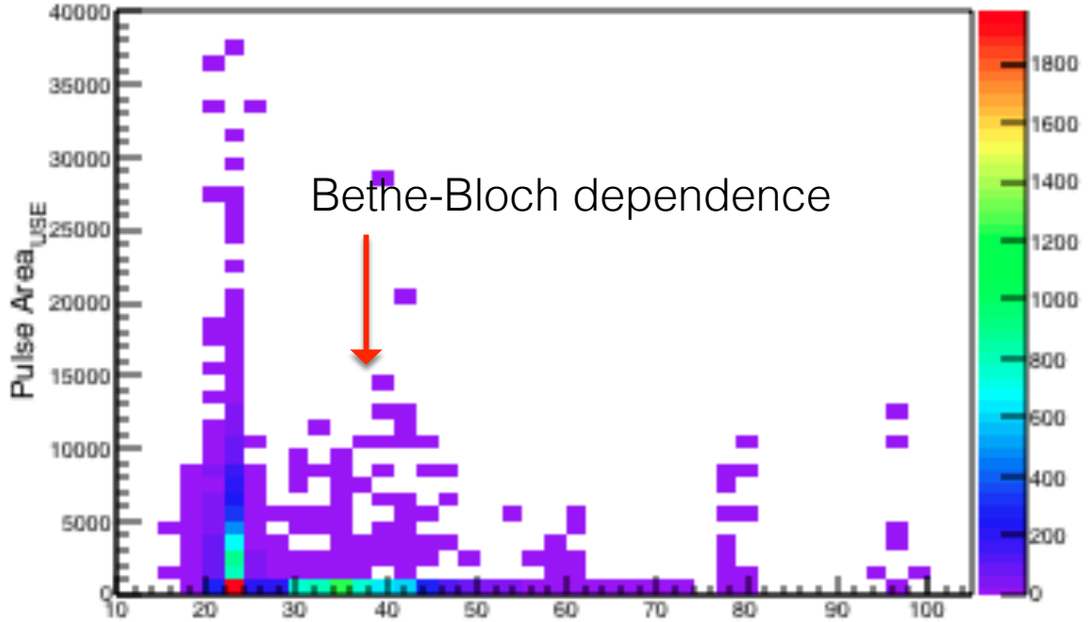


Pulse Area vs. TOF

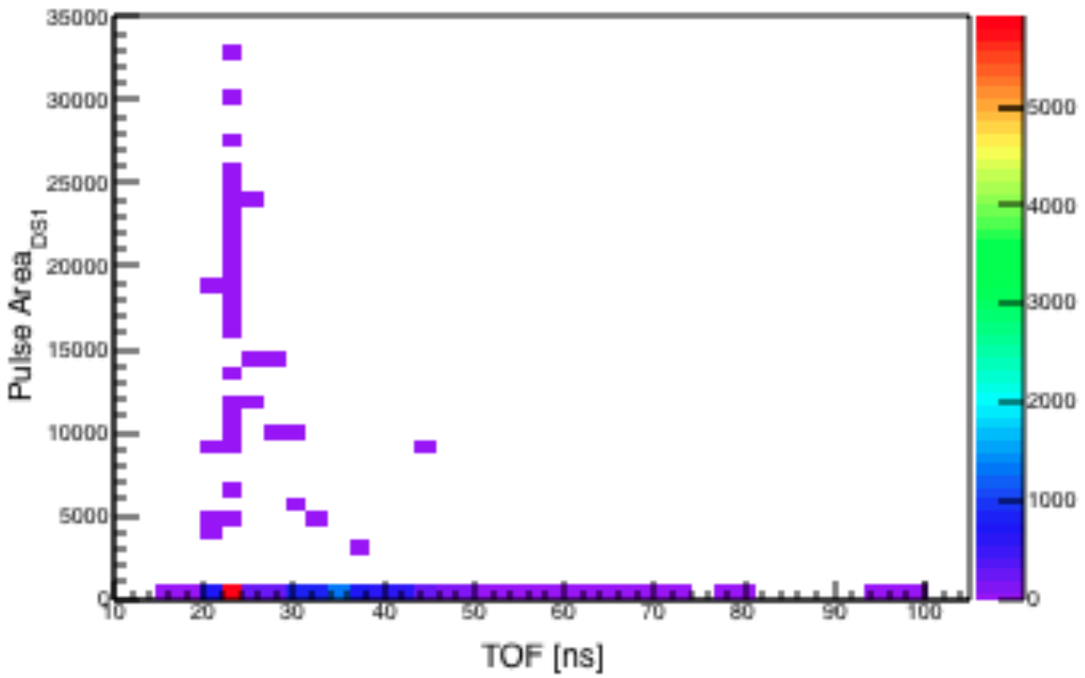
- Using runs 6258-6265(Positive Polarity)

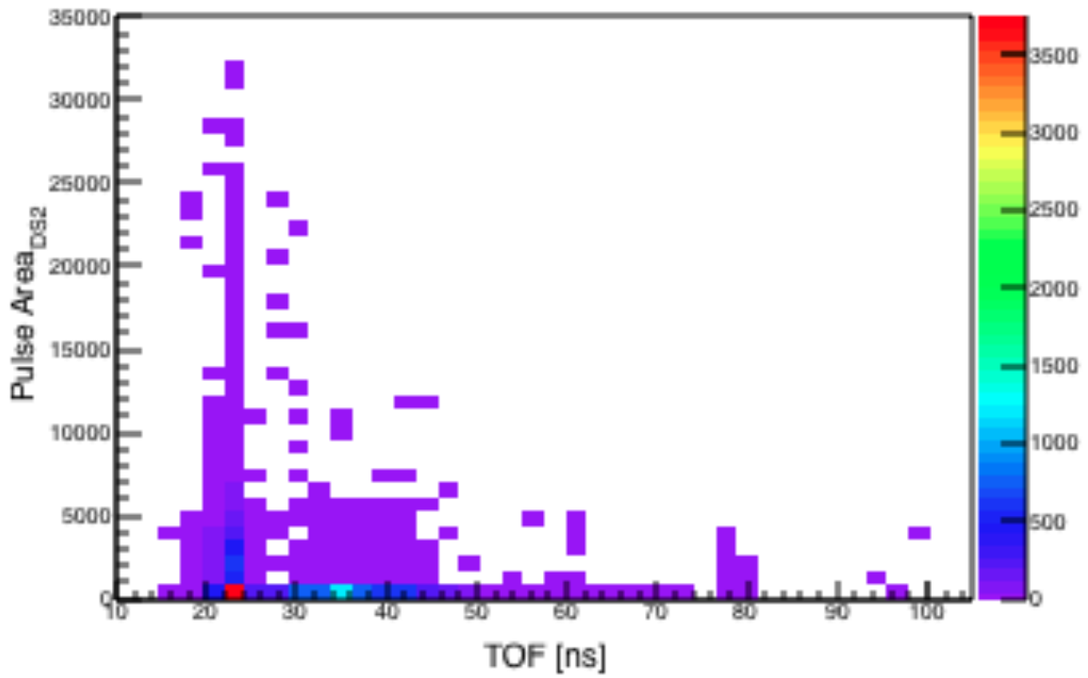
KEK:





UT:

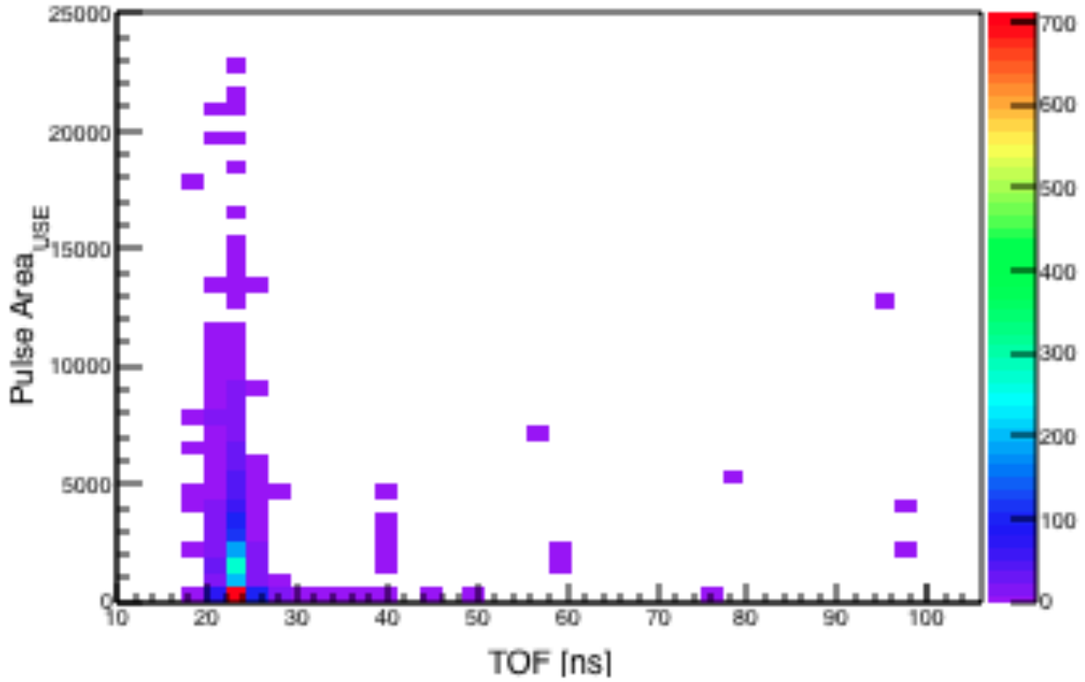


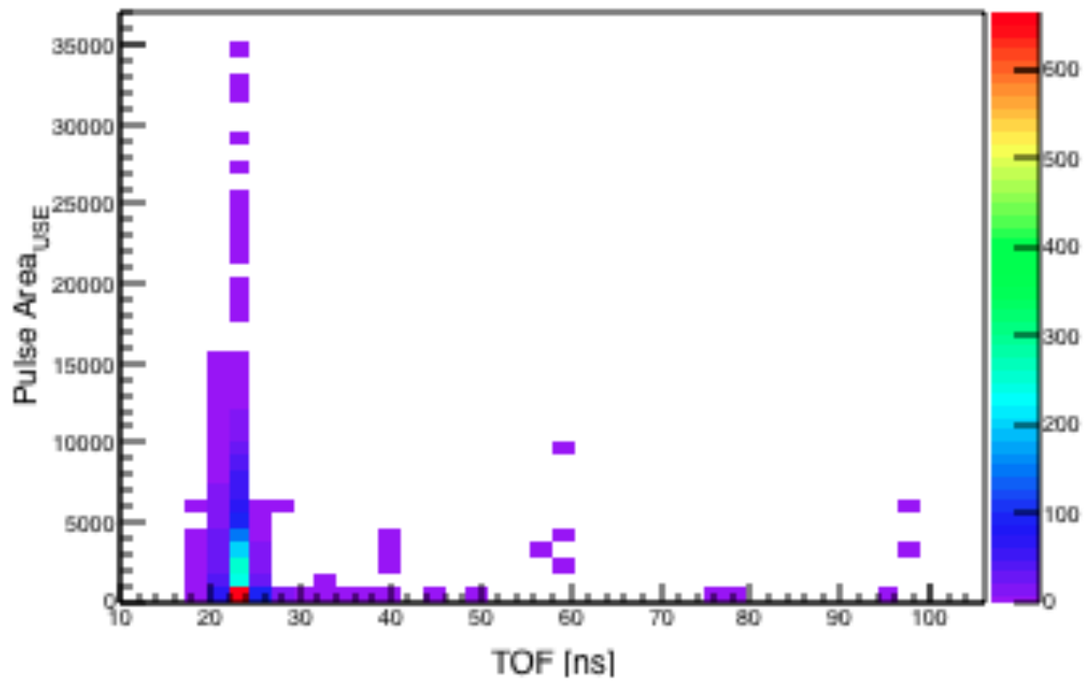


Pulse Area vs. TOF

- Using runs 6100-6329(Negative Polarity)
- We can focus on just on muons and pions separation analysis.

KEK:





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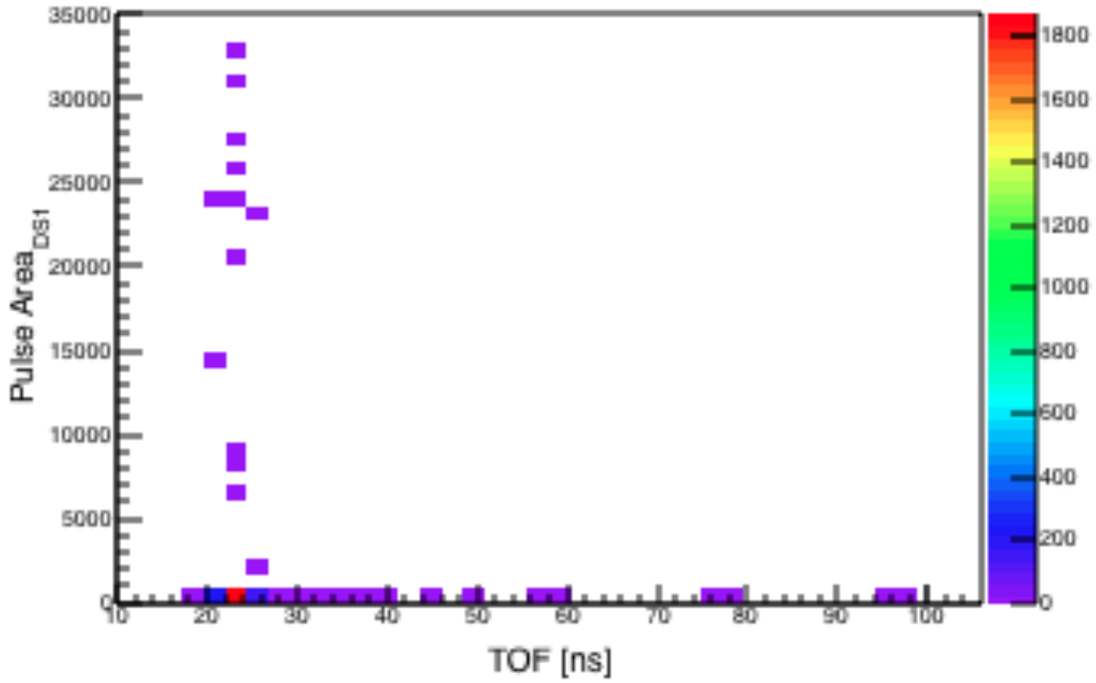
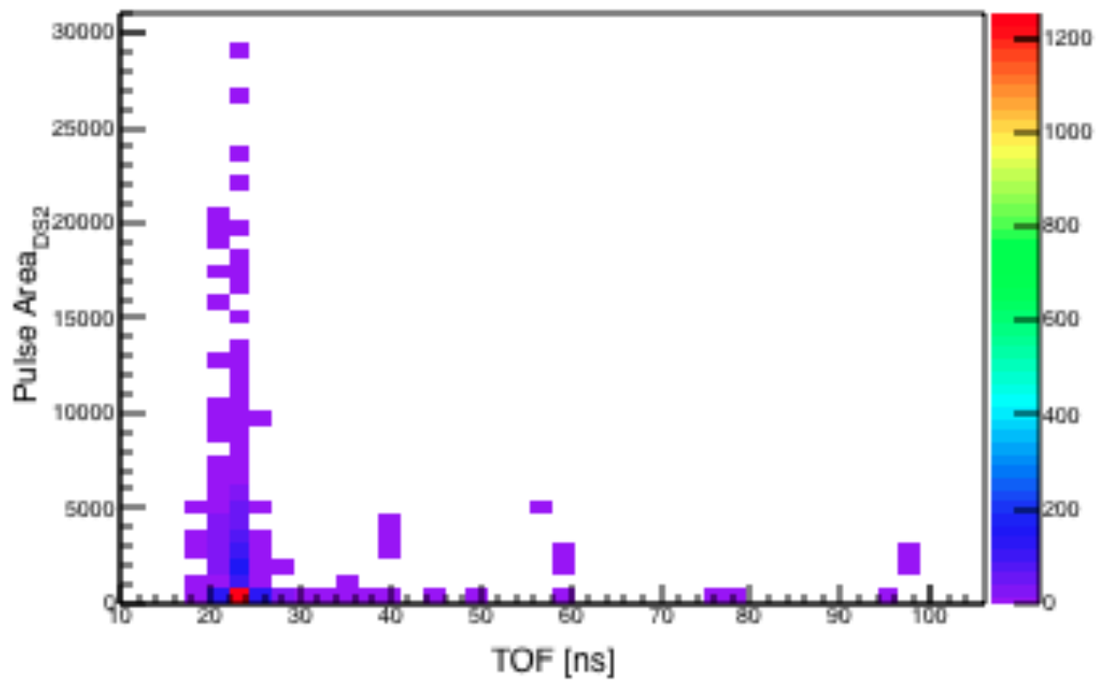
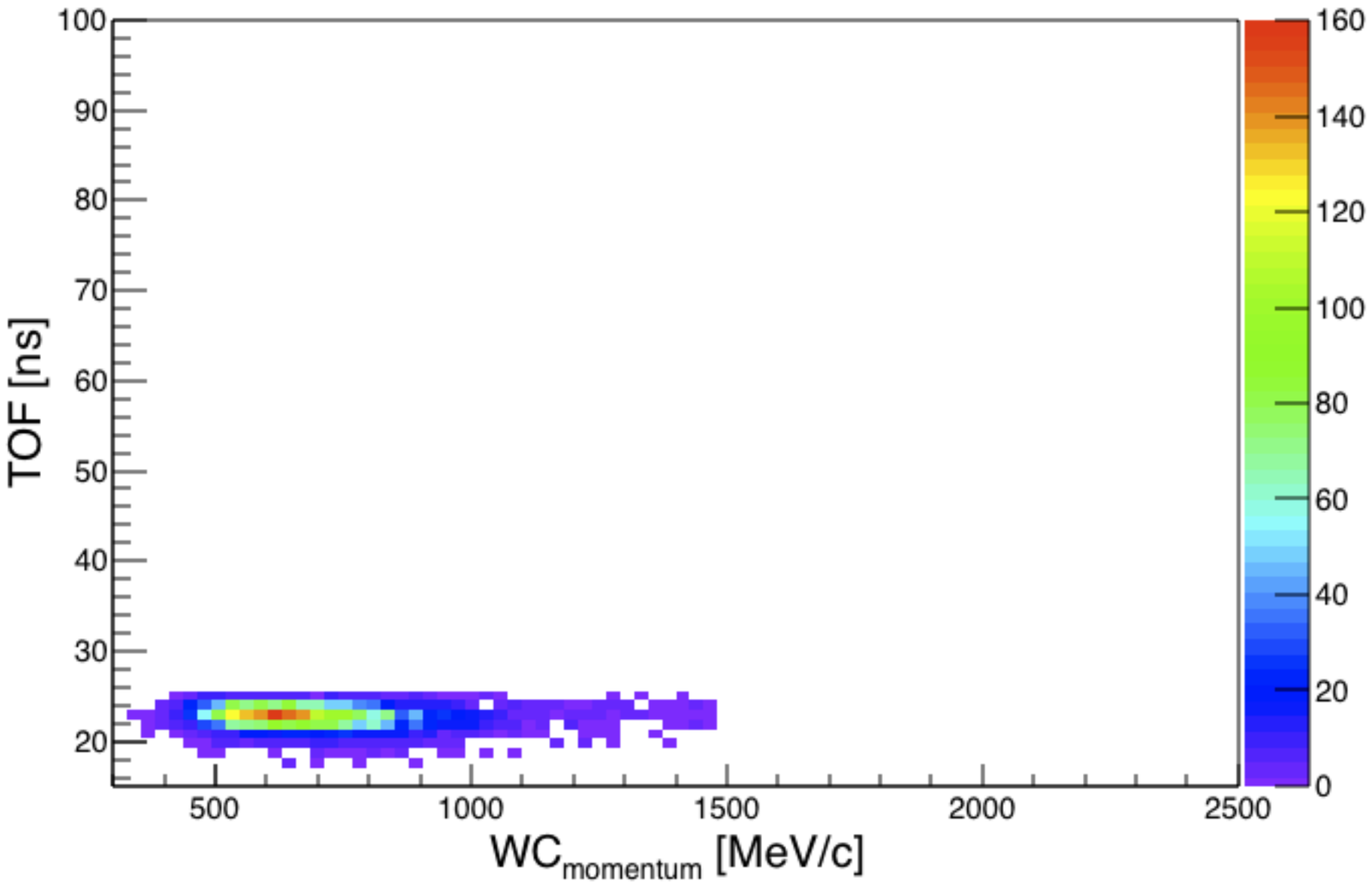




TOF

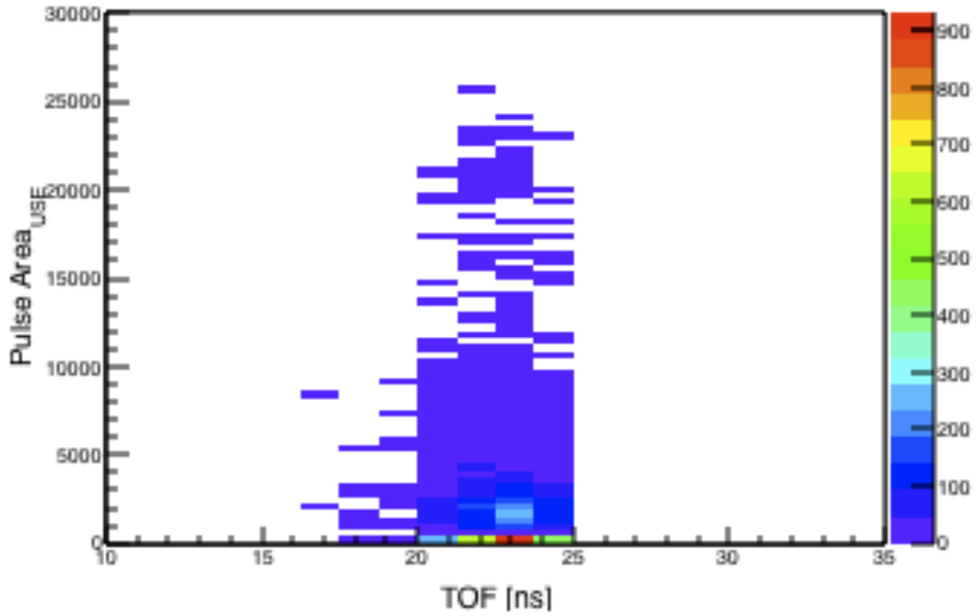
- Positive polarity data has protons, so by studying negative polarity data, we are able to focus strictly on the analysis of π-μ separation since anti-protons rarely show up in our negative polarity data. A preliminary particle identification hypothesis is possible utilizing the TOF and wire chamber track momentum profile for positive polarity data. π/μ events should lie between 0 ns < TOF < 225 ns and 100 MeV/c < P < 1500 Mev/c.

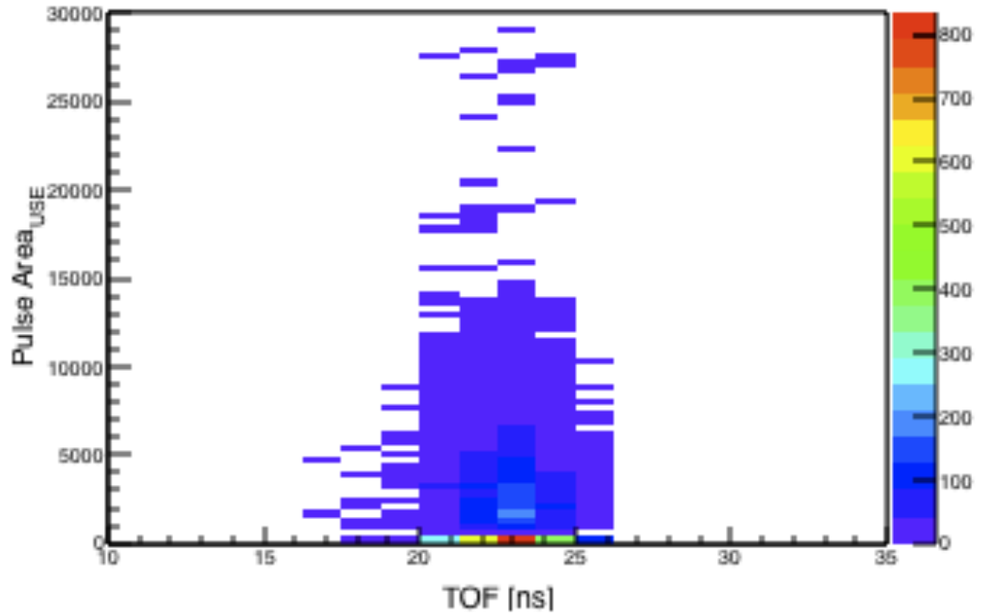


Pulse Area vs. TOF

- We can now focus studies on π-μ separation for positive polarity. Pulse area vs TOF from each aerogel Cherenkov detectors PMT is shown following the TOF selection cuts made for eliminating protons.

KEK:





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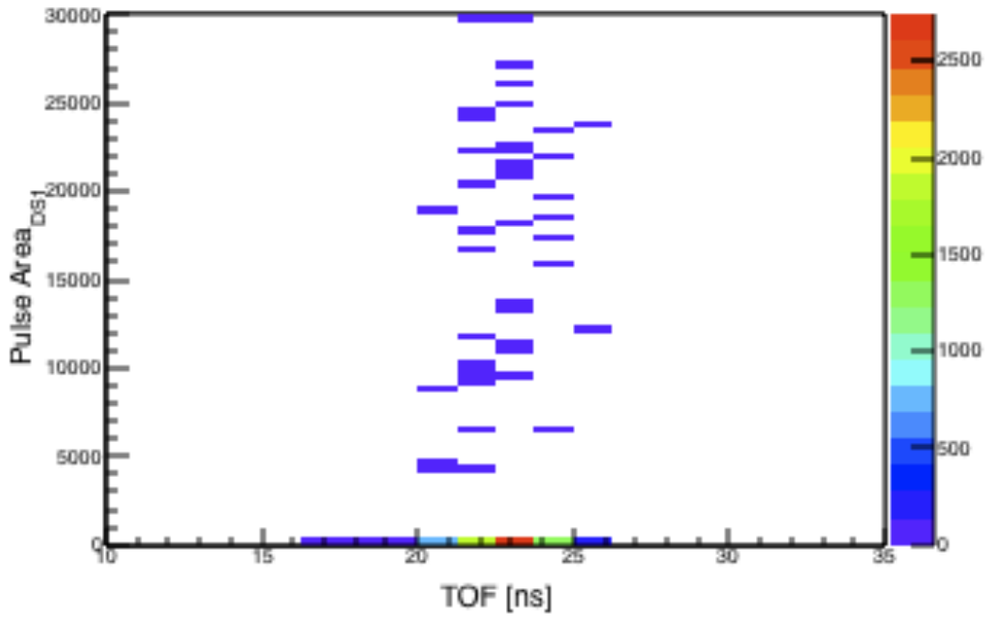
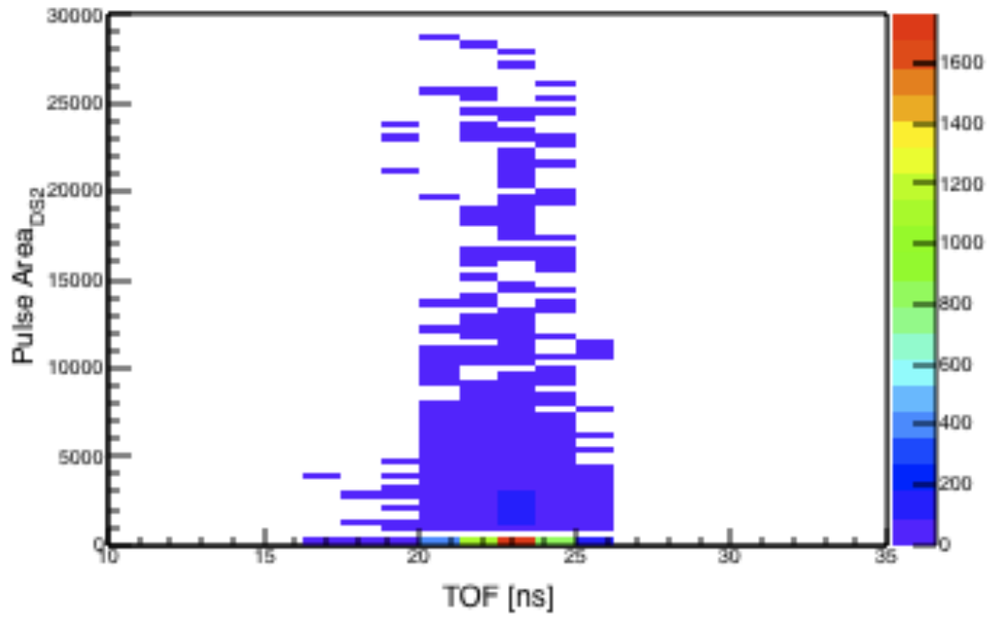
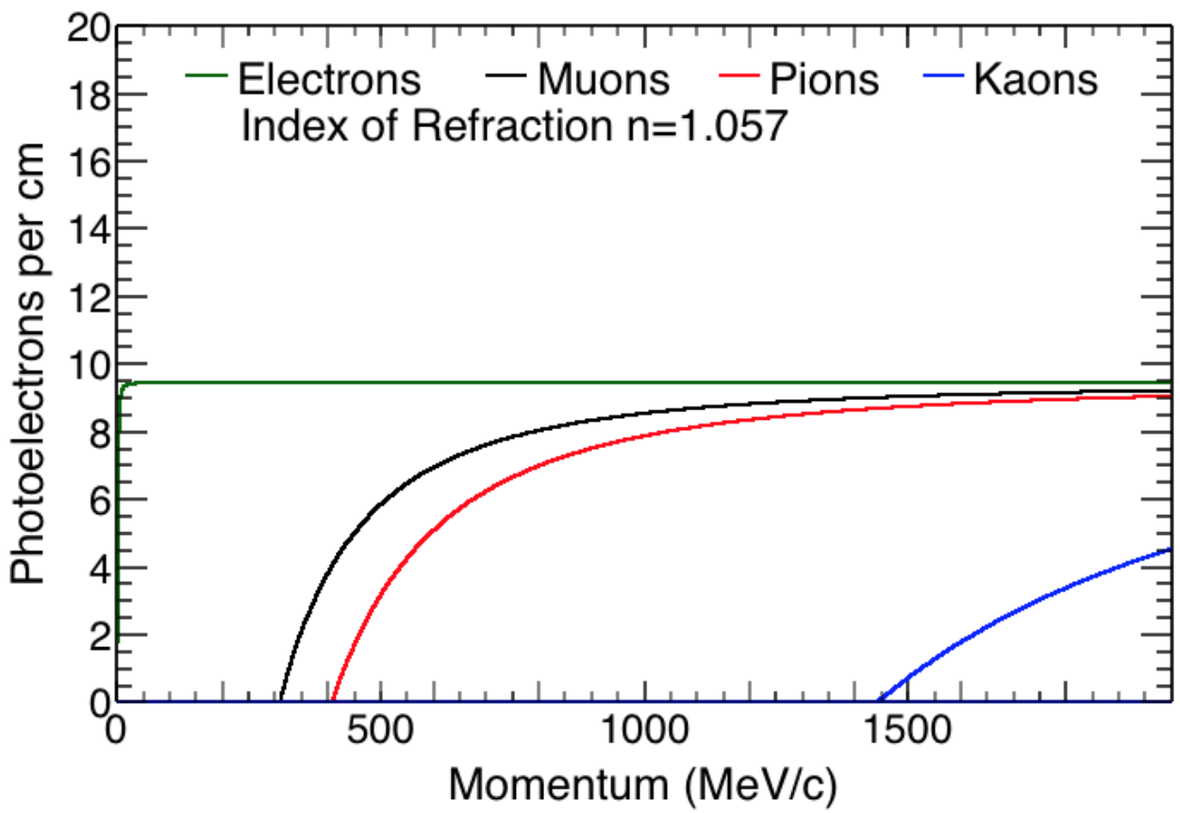


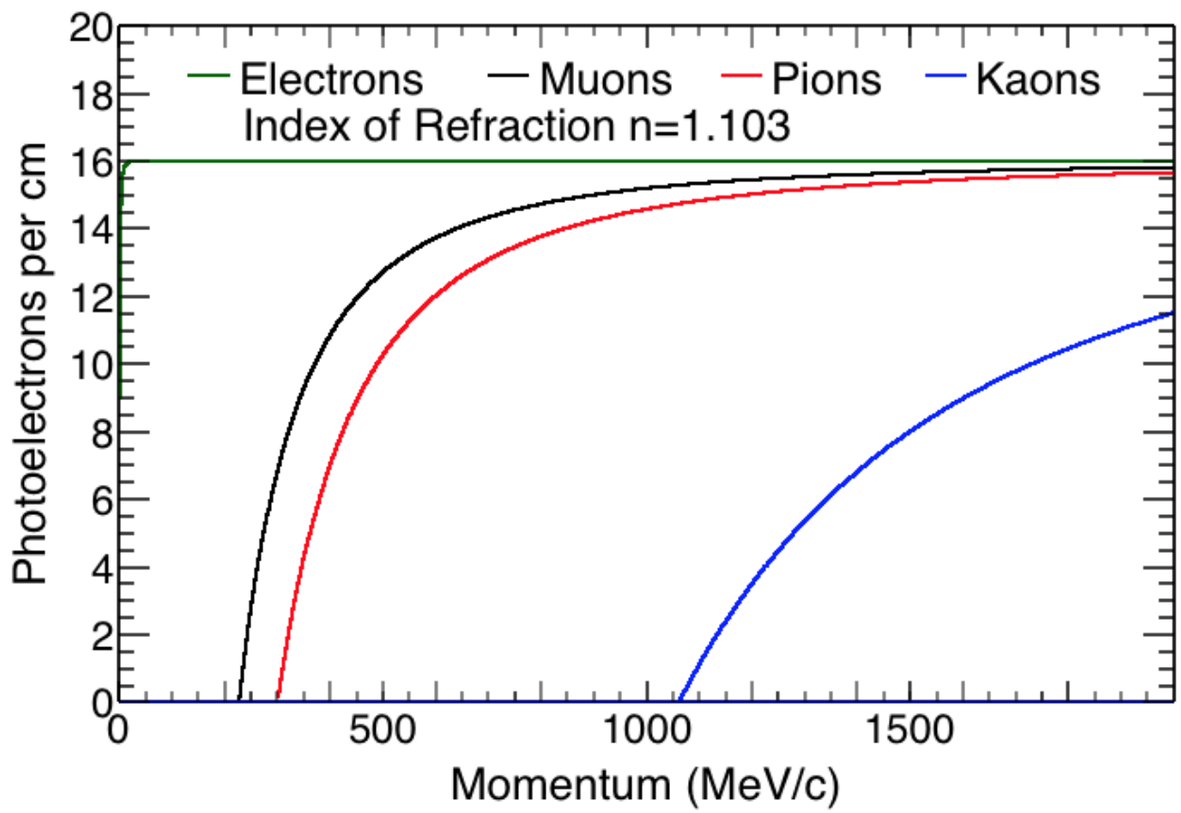


Aerogel Analysis

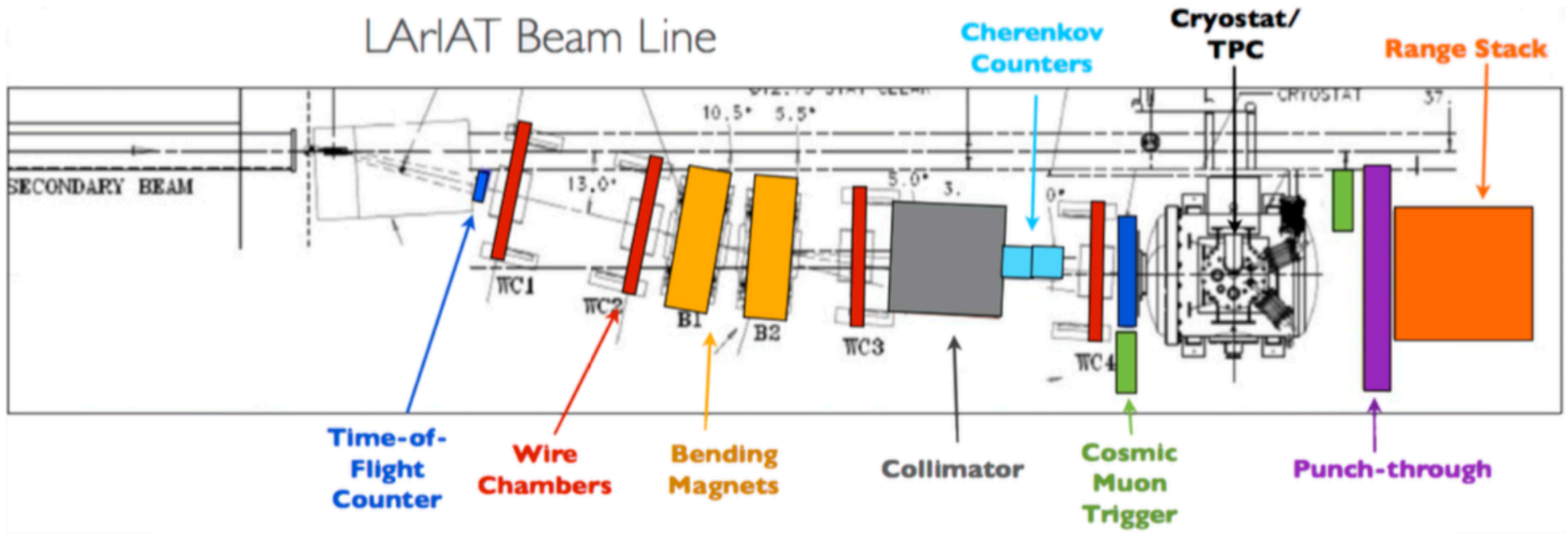
- Aiming to separate muons and pions in a momentum range where muons emit Cherenkov radiation while pions do not.
- Different indices of refraction are sensitive to different momentum ranges.
- The combination of the two aerogel Cherenkov counters, pions and muon can be identified for p<400MeV/c

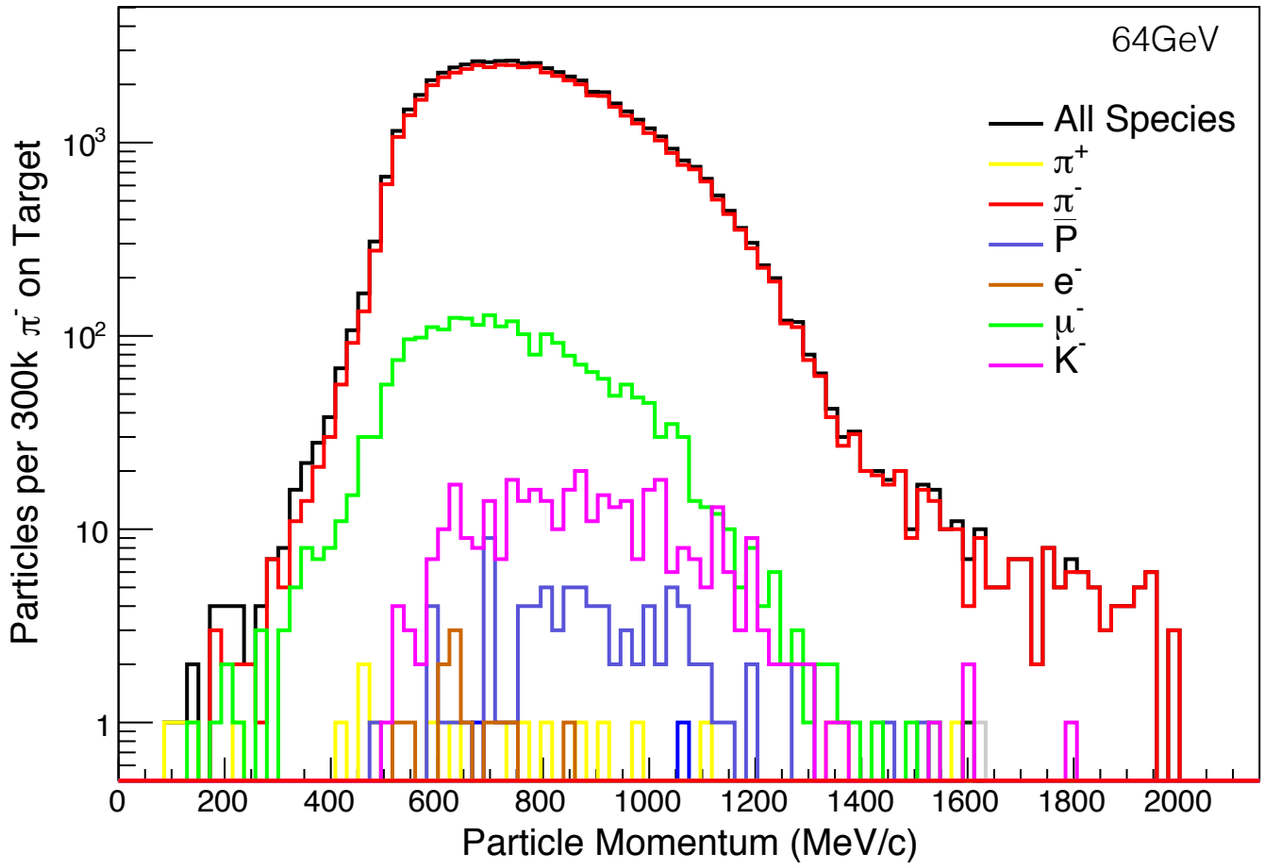
Aerogel Counter	n=1.11	n=1.057
200-300MeV/c	π μ	π μ
300-400MeV/c	π μ	π μ





MC Beam Composition Studies





- How can we use beam simulation help understand the aerogel counters?
- How can we use aerogel counters help understand the beam simulation?

MC Beam Composition Studies (Ideal Case)

- We can set constraints to the WC by requiring hits in the AG counter
- We can assume efficiencies for muons and pions to be:

  Aerogel Detector index n=1.05

  0% for p_μ < 310MeV, 100% for 310MeV < p_μ

  0% for p_π < 440MeV, 100% for 440MeV < p_π

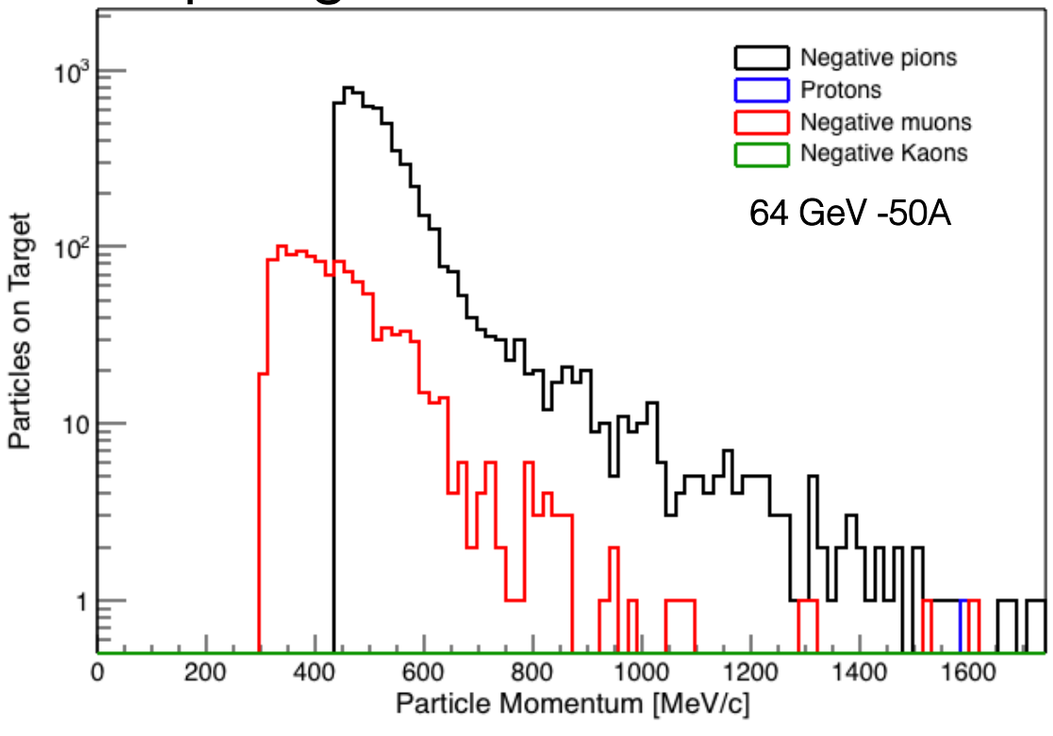
  Aerogel Detector index n=1.103

  0% for p_μ < 220MeV, 100% for 220MeV < p_μ

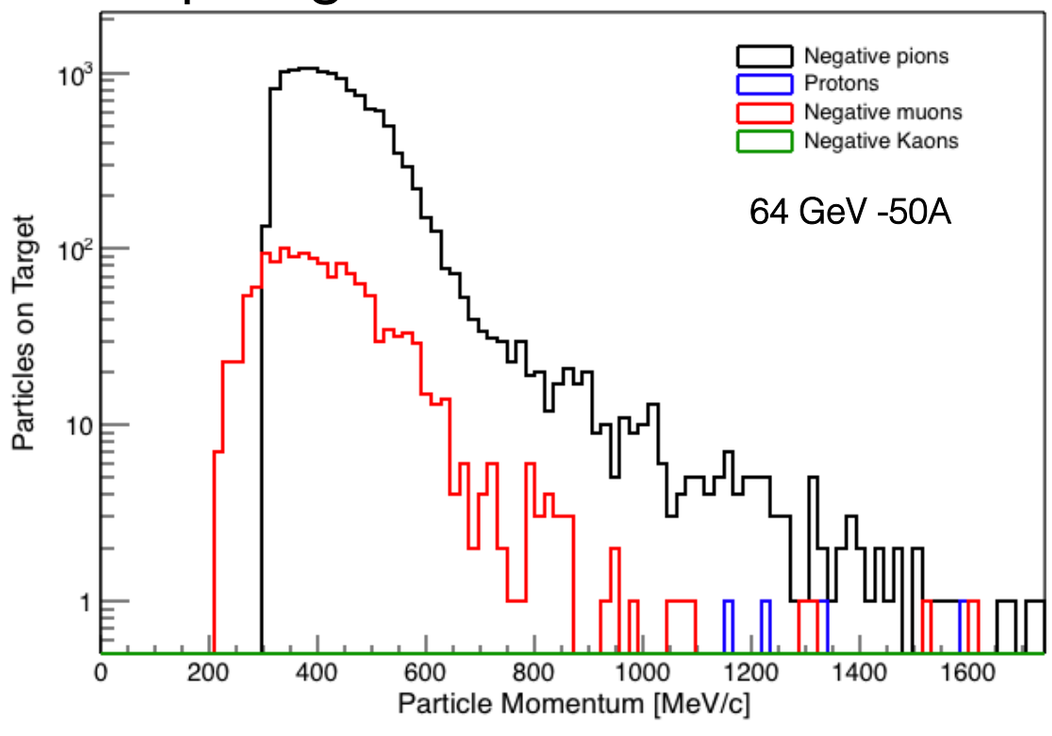
  0% for p_π < 310MeV, 100% for 310MeV < p_π

MC Beam Composition Studies (Ideal Case)

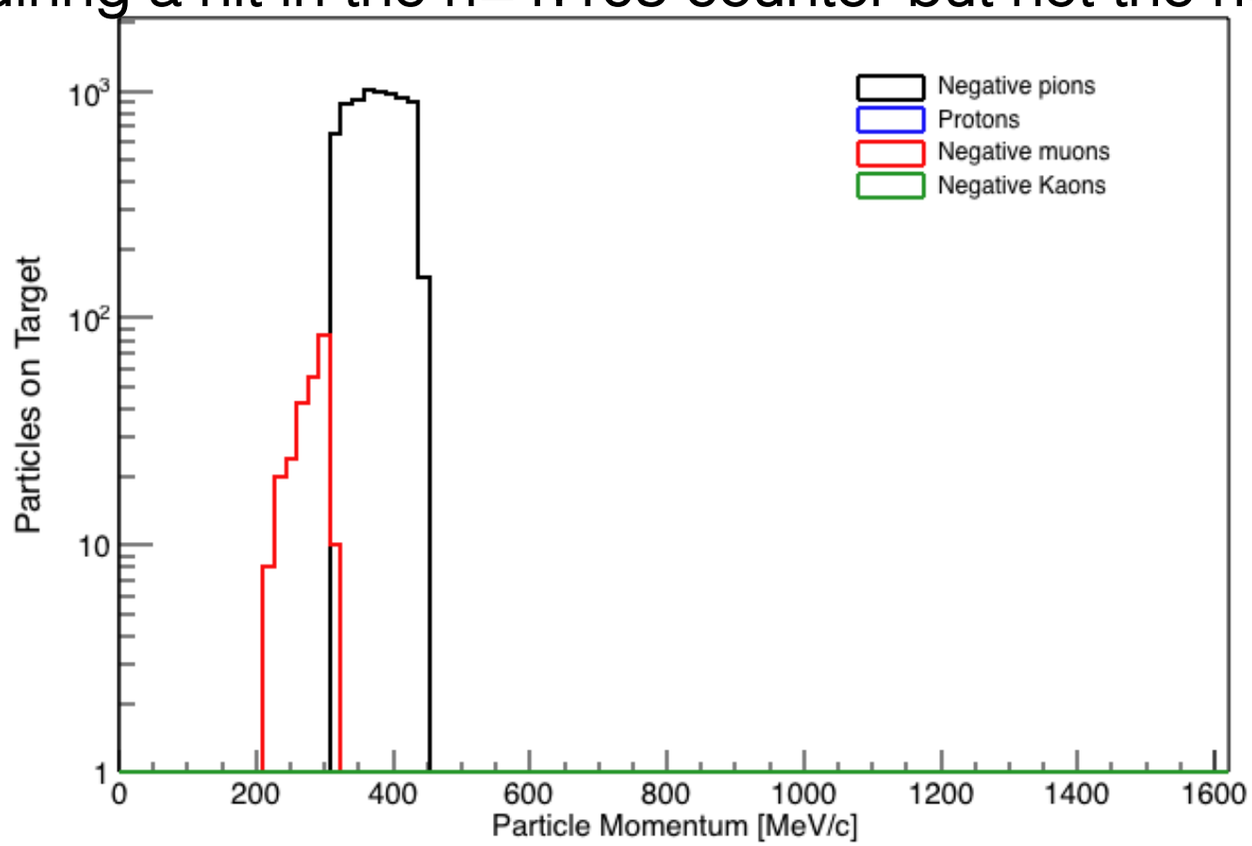
Requiring a hit in the n=1.057 counter



Requiring a hit in the n=1.103 counter

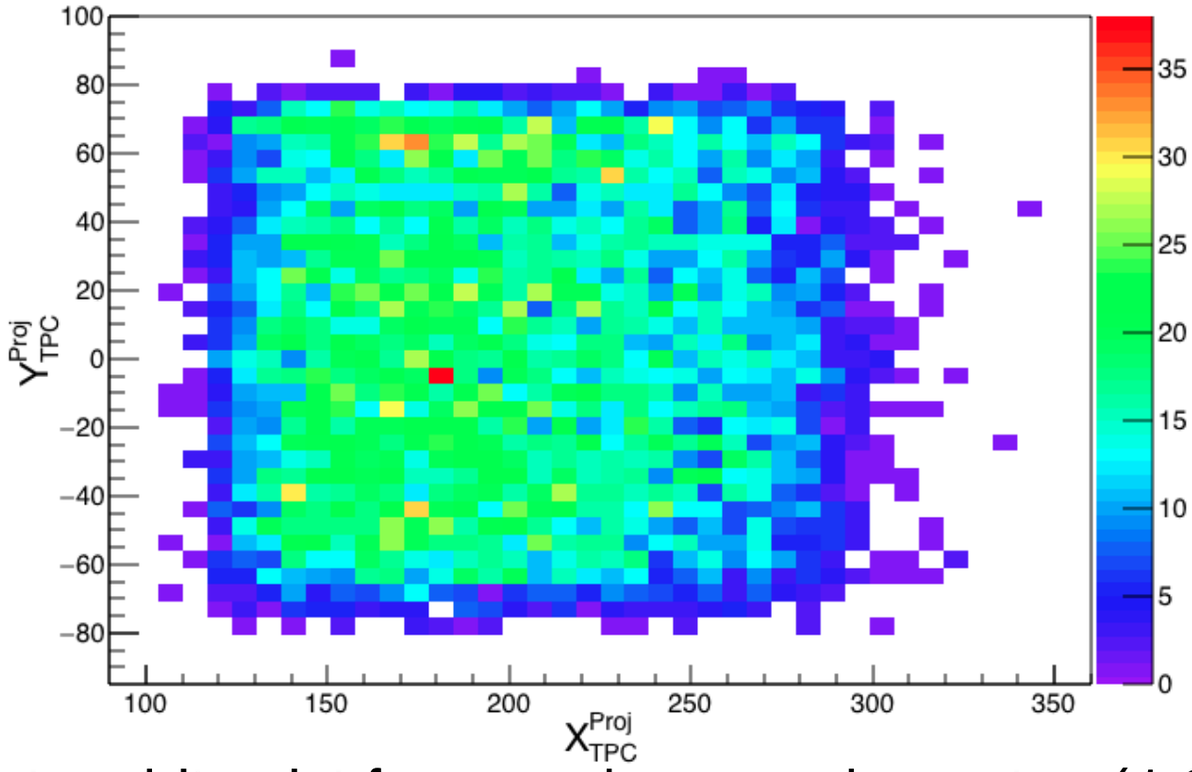


Requiring a hit in the n=1.103 counter but not the n= 1.057

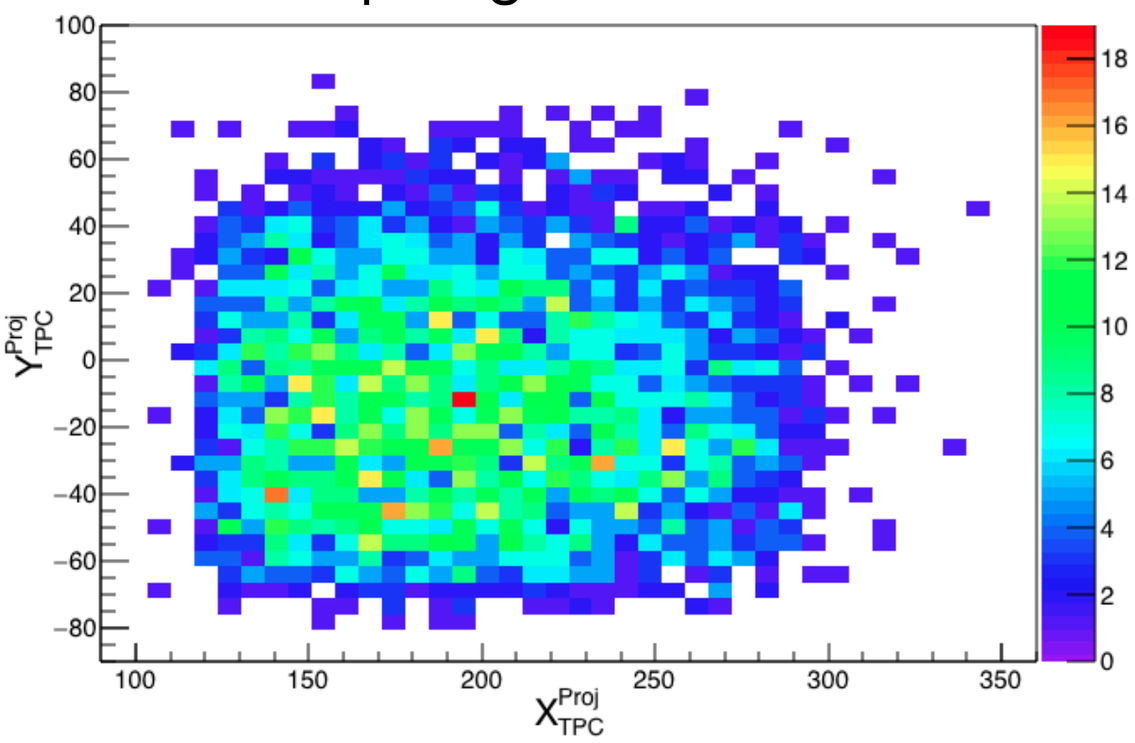


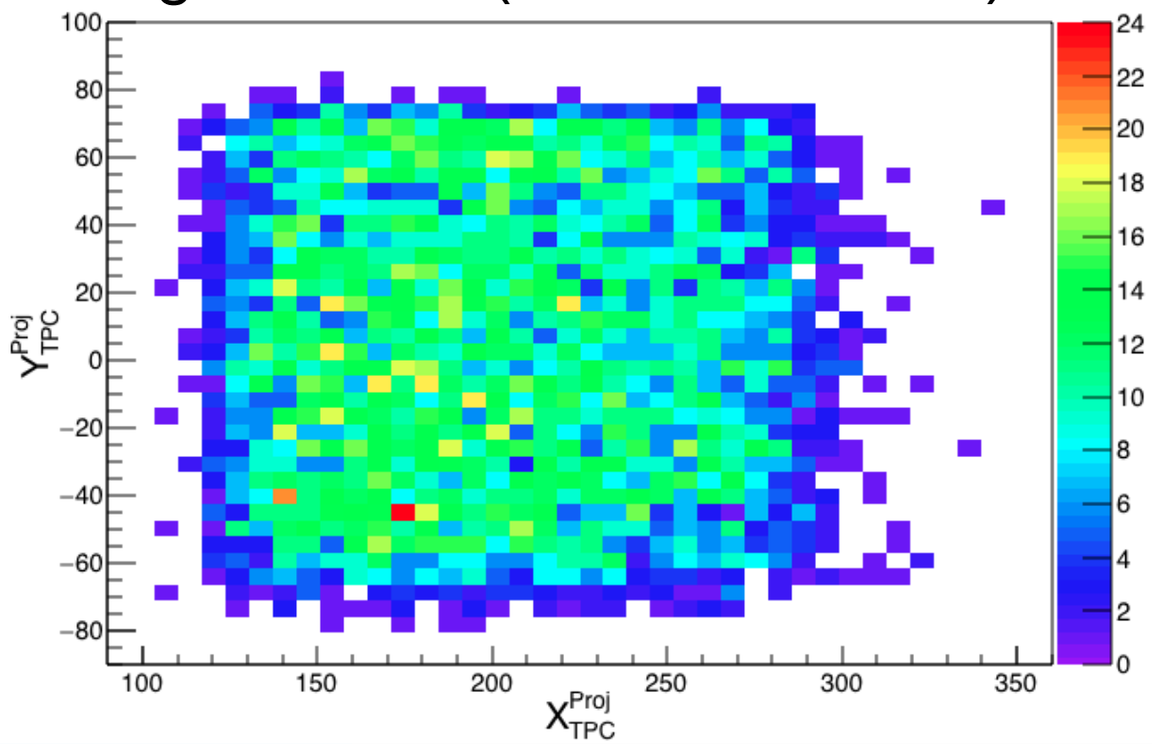
WC Infomation

- Getting the X and Y position from the WC of a track at the TPC front face.
- Working on projection of WC tracks to aerogel counters.



- Requiring that an hit exist from each aerogel counters(1.057 and 1.1103)

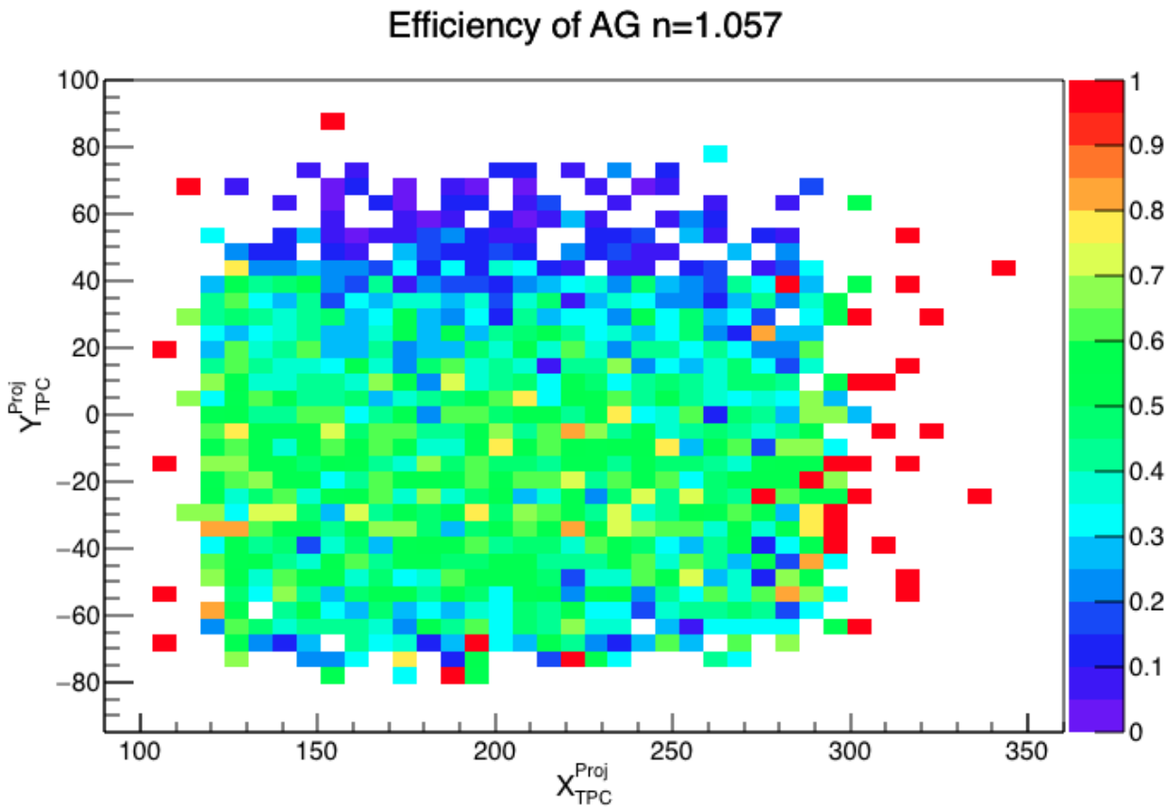


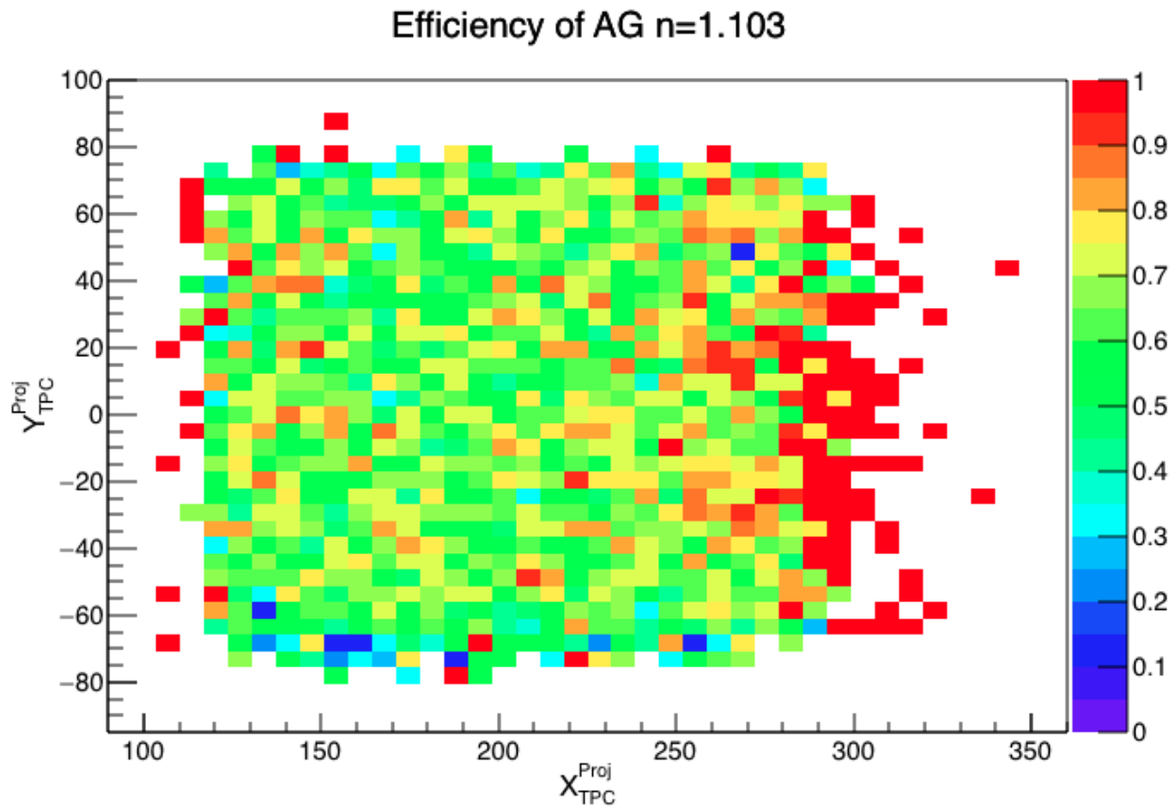


WC Infomation

❖ Calculate the efficiency for requiring hits in each AG counter.

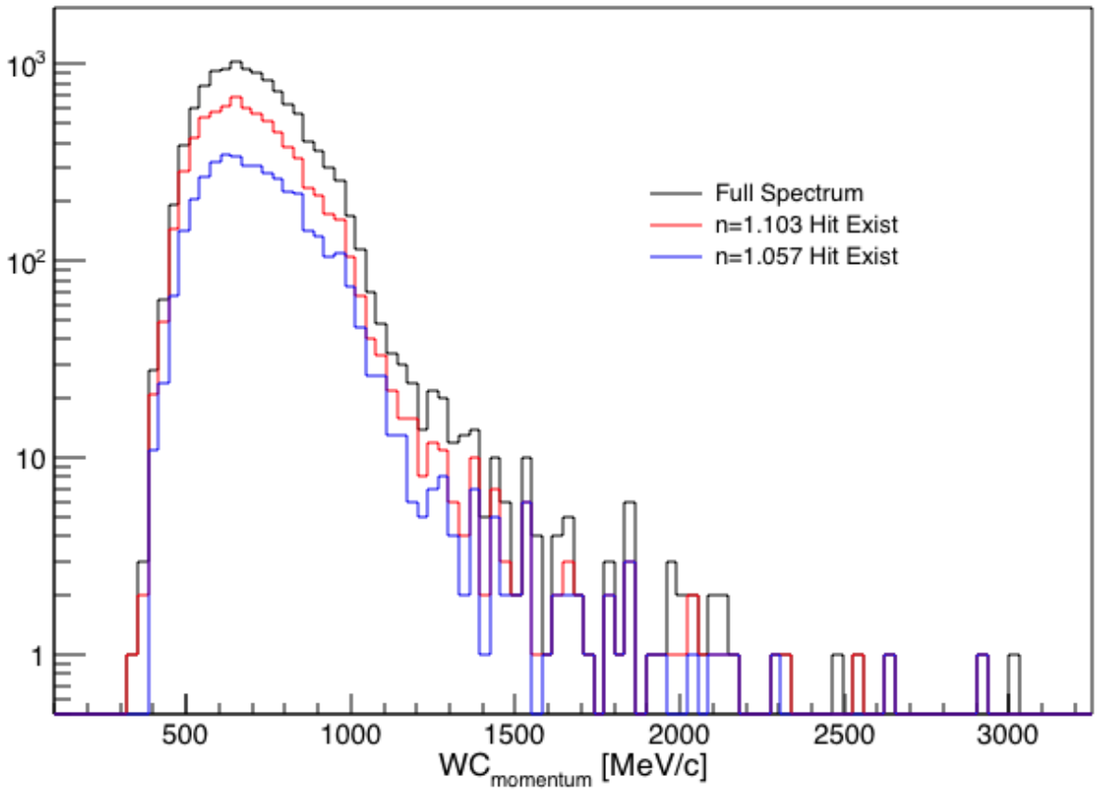
$$\varepsilon_{track} = \frac{WC\ requiring\ AG\ hit}{Total\ WC\ hits}$$





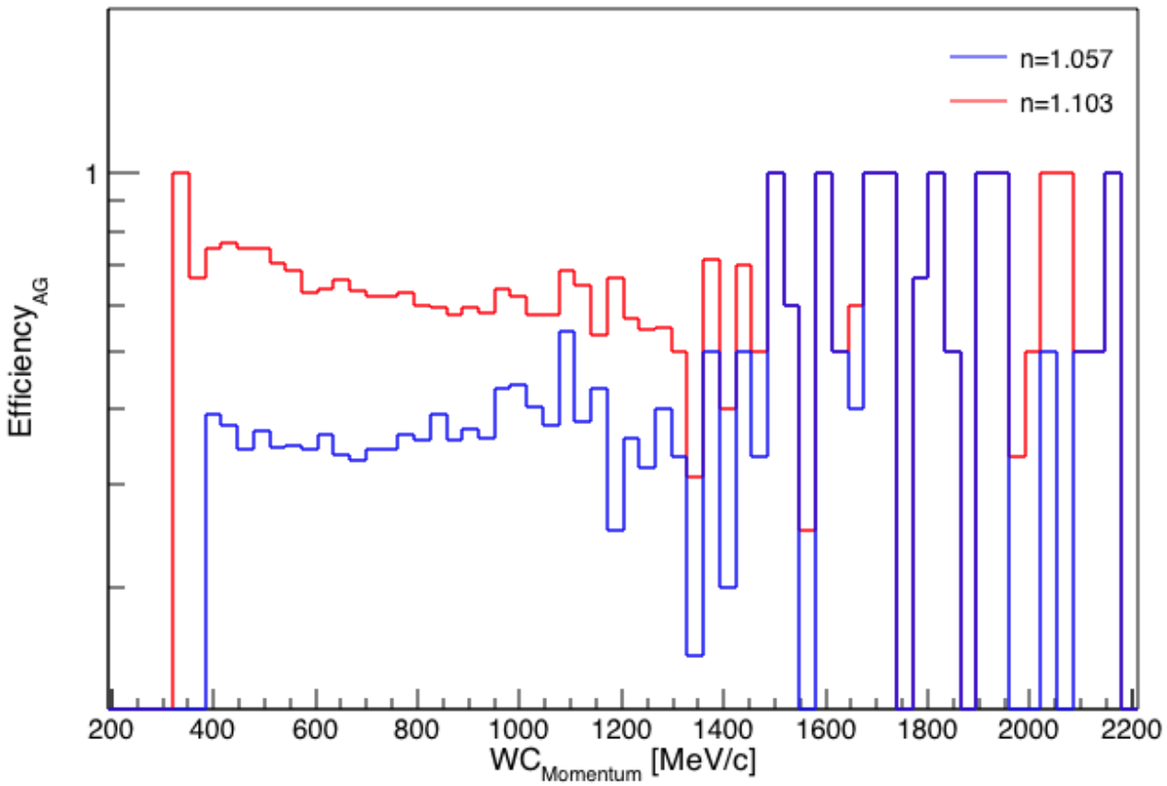
WC Momentum & Aerogel

- Total WC momentum with Aerogel hit exist requirements
- This is positive polarity data with no cuts to get rid of protons.
- This is 100A data where all muons and pions should be above Cherenkov threshold.



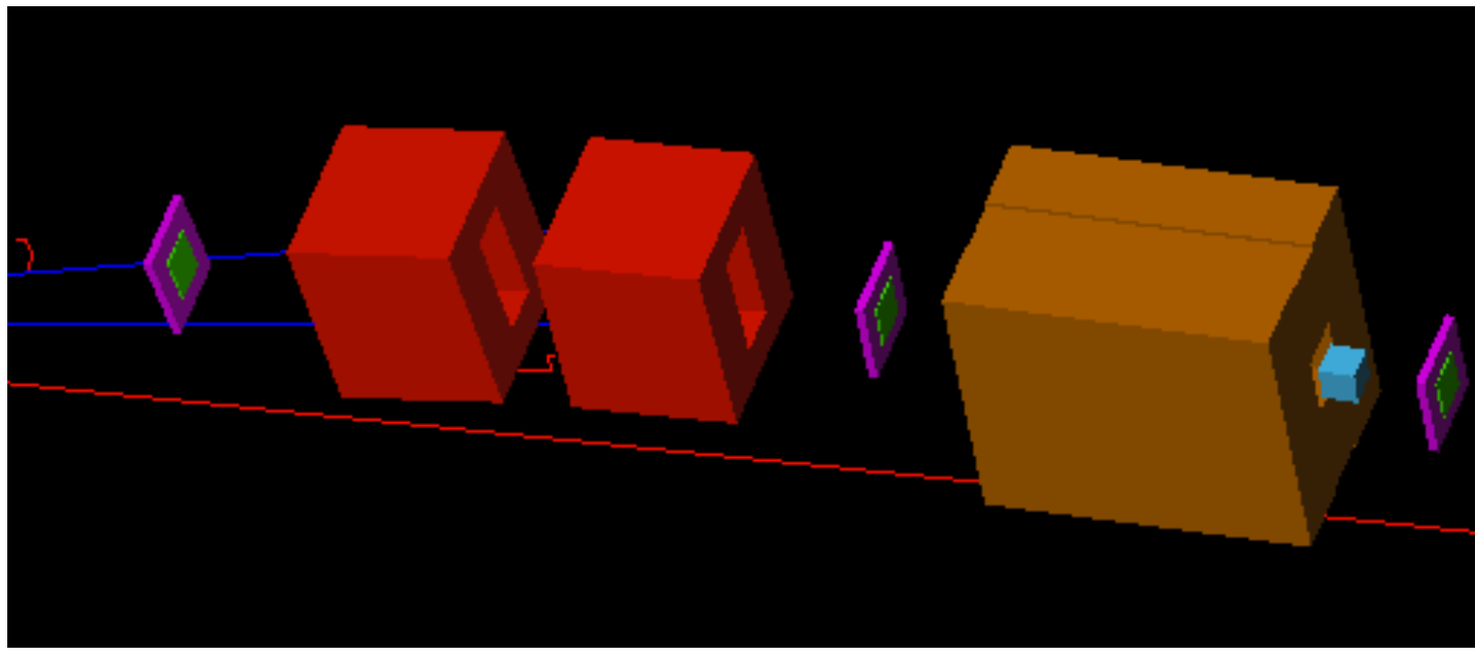
$$\varepsilon_{momentum} = \frac{WC_{momentum}\ require\ AG\ hit}{Total\ WC_{momentum}}$$

- The efficiency of the wire chamber momentum when requiring hits from each aerogel Cherenkov detector. n=1057 becomes more efficient at the lower momentum.
- We can see clear a region where we identify particles at less then 400MeV/c



Beamline Simulation

❖ Add aerogel counter in the G4Beamline Simulation(Currently testing)



APPROXIMATION: the octagonal Cherenkov2 is approximated as a circle
APPROXIMATION: an additional window is used in place of the mirror

- material aerogel density=0.2 Si,0.292 O,0.666 H,0.042
- tubs Cherenkov2Window outerRadius=400 length=1.0 material=Al color=0,0,1
- virtualdetector Cherenkov2 radius=425 length=100 material=aerogel color=0,0,1 tubs Cherenkov2Light outerRadius=640 length=367 material=Air color=1,1,1 material calorimeter density=3.7 Pb,0.85 scintillator,0.15
- virtualdetector Calorimeter width=1200 height=1200 length=160 material=calorimeter color=0,1,1

http://muonsinc.com/muons3/g4beamline/G4beamlineUsersGuide.pdf

Conclusion

- Scanning over remaining negative and positive polarity data to increase statistics and see if can have a better look at the Bethe-Bloch dependence.
- Calculate the efficiencies for detecting pions vs protons for pulse area versus TOF.
- We can now get the position of hits for each wire chamber?
- Next: I will use the wire chamber information in the anatree is able to tell us the X and Y position of a particle in WC3 and WC4 to estimate the position of particles passing through the aerogel counters. The calculate the efficiencies for each aerogel counter for hints of separation.